Diagnosis and Treatment of (Mild) Traumatic Brain Injury

John Speed MBBS

University of Utah

Utah Labor Commission

Workers' Compensation Educational Conference

September 2013

UNIVERSITY OF UTAH SCHOOL OF MEDICINE

Definition

- Traumatically induced physiologic disruption of brain function with at least one of:
  - Loss of consciousness (LOC)
  - Loss of memory of events immediately before/after injury
  - Altered mental status at time of injury
  - Focal neurological deficits

Definition (Injury Criteria)

(1) LOC ≤30 minutes
(Note: LOC not necessary for MTBI to have occurred)

(2) GCS (Glasgow Coma Scale)
score 13-15 after 30 minutes

(3) Post-traumatic amnesia ≤ 24/hrs.

Mild Traumatic Brain Injury (MTBI) Overview

- TBI Incidence
  - 1-5 million injuries per year
  - 500,000 hospitalizations/year
  - Estimated 1.5 million yearly occurrences of transient LOC not resulting in hospitalization
  - MTBI - ~80% of all hospitalizations/ER visits for TBI

Incidence

- 15% of people with MTBI still have symptoms after one year
- 20-40% of patients sustaining MTBI do not seek medical care

Demographics

- Most common in 16-34 year age group
- >60 years old is next most common
- Young (<5) is next

Causes

- Motor vehicle accidents
  - Males 14-24
  - Alcohol often involved
- Sports/ recreational
- Assault

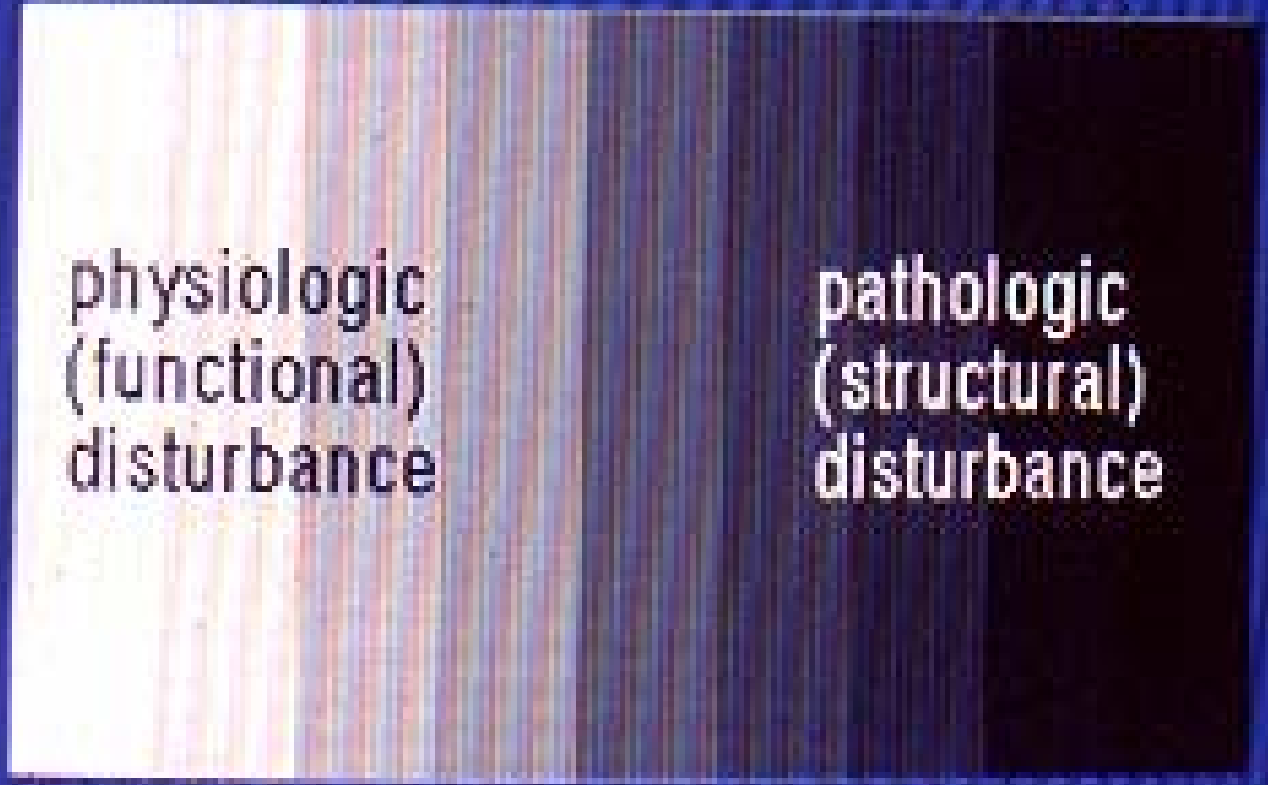
Pathophysiology

- Diffuse axonal injury
- Punctate hemorrhages
- Impairment tends to correlate with the extent of DAI

DAI

Concussion syndromes

Traumatic coma



MEMORY LOSS

TRANSIENT LOC

PROLONGED LOC

Imaging

- No need if have normal exam by 30 minutes
  - If persistent symptoms, or focal exam by 30 minutes, CT scan
- Normal CT and MRI in >99% of mild TBI
- No clinical role for PET or SPECT scans

Post-concussion syndrome

- Subjective phenomena:
  - Headache, fatigue, insomnia, irritability, emotional lability, anxiety, depression, photosensitivity, dizziness, inattention, memory deficits
- PCS has been a defining characteristic of mild TBI
- High base rate for these symptoms in the general population, and is not pathognomonic for mild TBI

Differential Diagnosis

- PTSD
- Depression
- Pain (headache)
- Medication side effects
- Anxiety
- Panic disorder
- Malingering/conversion disorder
- There may be more than one diagnosis made

Injury Characteristics

- Early symptoms may be more reflective of the physical injury
- Prolonged symptoms may more reflect a combination of neurologic, psychologic, and socioeconomic-demographic influences
- Thus, time course of symptoms is relevant

Early Deficits

- Most consistent pattern of early deficits:
  - Impaired attention, concentration, speed of information processing, and memory
  - Expect improvement over time, with resolution within several months

Post concussion syndrome

- Physical symptoms
  - Headache (+/- nausea/vomiting)
  - Dizziness/balance impairment
  - Hearing loss
  - Sleep disturbance
  - Smell/taste changes
  - Visual symptoms
- Cognitive symptoms
  - Attention, memory, judgement
- Behavioral changes
  - Irritability, depression
- Other/Associated
  - Musculoskeletal- whiplash related syndromes

Workup

- Careful history
- Examination
  - Frontal release signs
  - Signs of increased tone
- Imaging rarely needed
- Neuropsychometric testing

Accurate Early Diagnosis

- Timely assessment in early post-injury period
- Three essential features:
  - Traumatic event of sufficient intensity
  - Transient change in mental status
  - No evidence of focal brain damage, intracranial hemorrhage, or skull fracture
- Later reconstruction of history can be problematic

Failure to recover as expected

- There are a number of alternative diagnostic considerations
- Mild TBI can be concurrent with another condition, or followed by another condition, or confused with another condition initially

Differential Diagnosis

- Actual Mild TBI
  - As single diagnosis
  - Combined with another pre-existing and/or post injury condition

Alternate Organic Considerations

- Moderate or serious TBI
- Pre-existing dementia
- Previous brain injuries
- Headache/other pain
- Medication side effects

Preexisting Nonorganic Conditions

- Psychiatric condition active at time of injury
- Dormant psychiatric condition reactivated by injury
- Preexisting personality characteristics interacting with injury circumstances
- Social/economic factors interacting with injury circumstances

Post-injury nonclinical conditions

- Compensation/litigation
- Malingering

Post-injury (new) Psychiatric Morbidity

- Depression
- Anxiety
- Post traumatic stress disorder
- Simple phobia
- Conversion disorder
- Hypochondriasis
- Factitious disorder

Conclusions

- Meticulous history is the cornerstone of accurate diagnosis
  - Police, paramedic, emergency room records
  - Mechanics of the injury
- Accurate diagnosis is necessary for effective treatment
- Potential to prospectively identify the “slow to recover” population

Treatment

- First, education and reassurance!
- Treat any associated conditions (whiplash, PTSD, etc)
- Cognitive therapy
  - "exercises for the brain"
  - Remediation vs compensatory strategies

Symptom management

- Usually rapidly resolve
  - Over 1-3 months in>85%
- 5-10% have persisting problems at one year
- Other factors may contribute to persistence of symptoms
  - Pain
  - Psychologic factors
  - Compensation/litigation
  - Preexisting factors
  - Medication side effects

Dizziness

- Traumatic etiologies include:
  - Peripheral vestibulopathy
    - Benign paroxysmal positional vertigo (BPPV), +/-
    - Labyrinthine concussion
      - May result in abnormal movement of otoliths, causing delayed response to head movement
      - This leads to a temporal difference in cerebellar input from visual, proprioceptive, and labyrinthine systems, resulting in dizziness
    - The Dix-Hallpike maneuver is diagnostic of labyrinthine caused dizziness

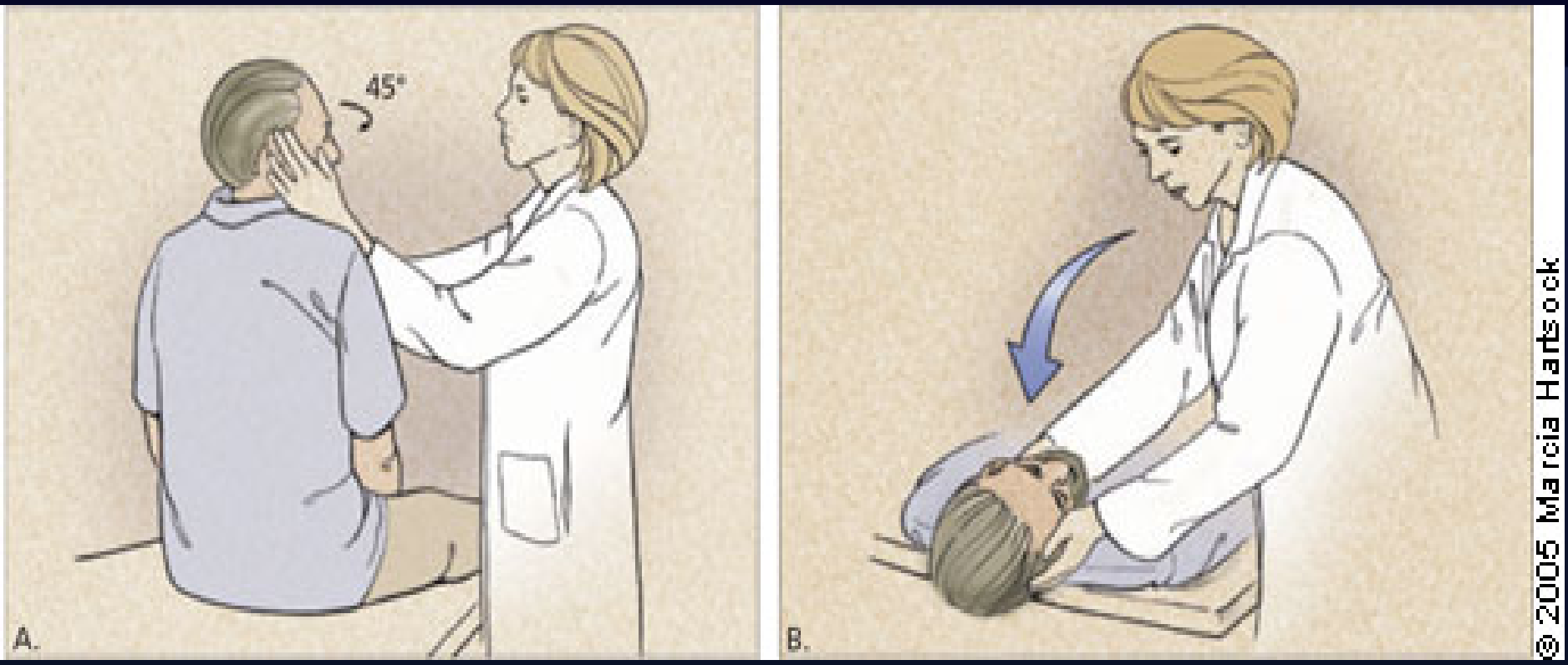


Figure 1. Dix-Hallpike maneuver (used to diagnose benign paroxysmal positional vertigo). This test consists of a series of two maneuvers: With the patient sitting on the examination table, facing forward, eyes open, the physician turns the patient's head 45 degrees to the right (A). The physician supports the patient's head as the patient lies back quickly from a sitting to supine position, ending with the head hanging 20 degrees off the end of the examination table. The patient remains in this position for 30 seconds (B). Then the patient returns to the upright position and is observed for 30 seconds. Next, the maneuver is repeated with the patient's head turned to the left. A positive test is indicated if any of these maneuvers provide vertigo with or without nystagmus.

Dizziness – other causes

- Cervicogenic
- Rare:
  - Central vestibulopathy due to brainstem injury
  - Post-traumatic migraine
  - Epilepsy

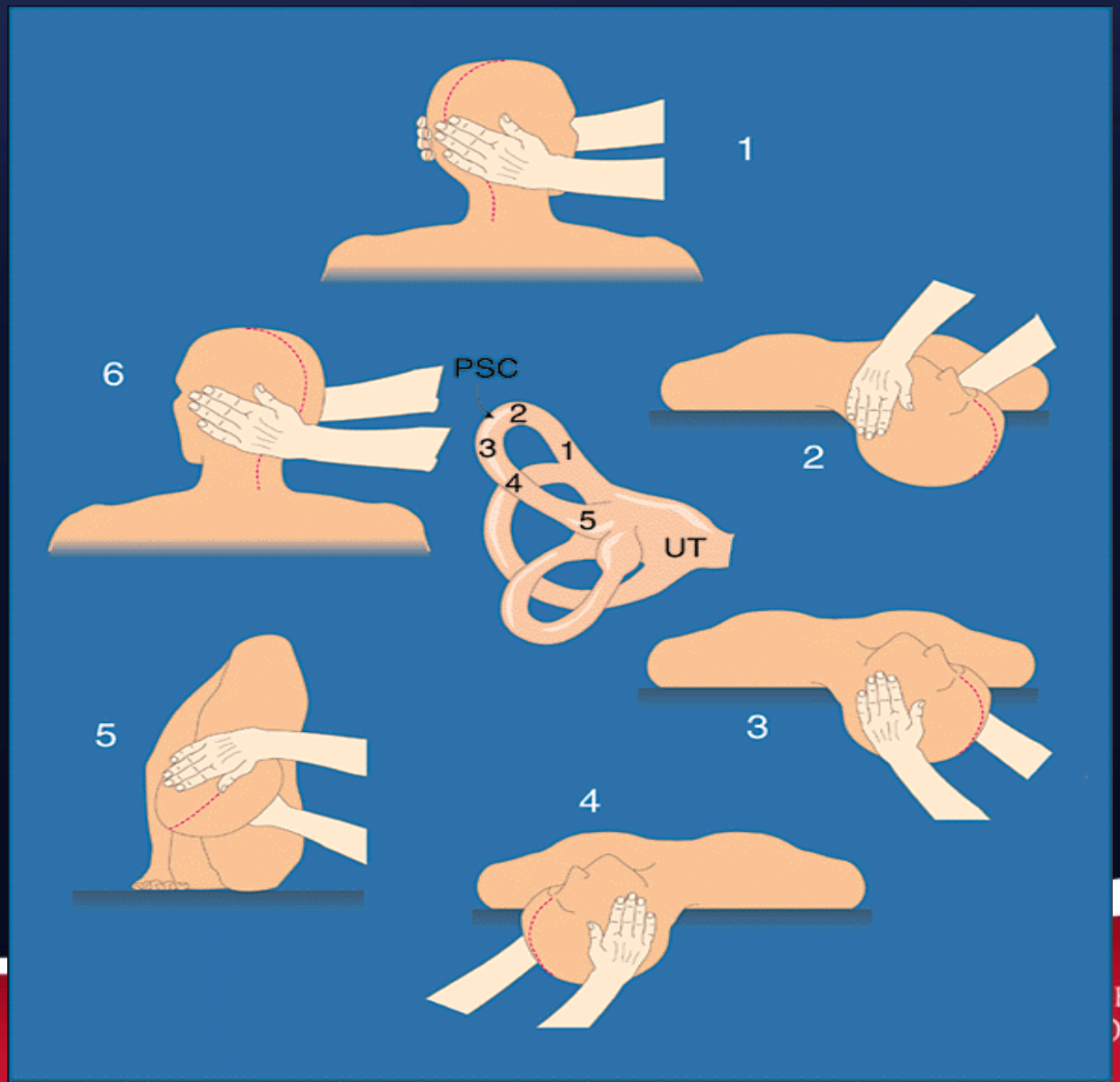
Dizziness - Management

- Usually self limiting
- Avoidance of provocative movement may slow recovery
- For persistent complaints:
  - Vestibular rehab
    - Effective, labor intensive
    - Addresses three components of balance
      - Neck range of motion
      - Visual tracking
      - Proprioceptive input

Vestibular rehab

- Identifies motions and positions that exacerbate symptoms and progressively exposes patient to these situations
- Repositioning maneuvers e.g. Epley
- Rapid mobilization outside of therapy is also important

Epley otolith repositioning maneuver



Dizziness - Medications

- Use relatively cautiously, as may slow recovery
- Limited efficacy, may work mainly by mildly sedating patient to blunt reaction to dizziness (scopolamine, meclizine)
- Buspirone 5-10 mg TID has been reported to be effective in case reports

Classification of Headache

1. Migraine
2. Tension-type HA
3. Cluster HA
4. Other primary HA
5. HA 2nd to head and/or neck trauma
6. HA 2nd to cranial or cervical vascular disorder
7. HA 2nd to non-vascular intracranial disorder

Classification of Headache

8. HA 2nd to a substance or its withdrawal
9. HA 2nd to infection
10. HA 2nd to disorder of homeostasis
11. HA 2nd to face or neck structures (cervicogenic)
12. HA 2nd to psychiatric disorder
13. Cranial neuralgias and central causes facial pain
14. Other

Evaluation: History

- Previous history of headache
  - type, frequency, age of onset, successful/unsuccessful management
- Family history of headache
  - Migraines
- Temporal correlation of headache with the injury
- Evolution of symptoms over time
- Treatment and treatment response history

Mechanism of Injury

- Moving or idling vehicle?
- Type of vehicle?
- Speed of contact?
- Condition of car?
- Condition of other occupants?
- Position or activity of patient at the time of impact

Description of Headache

Site

Nature

Radiation

Exacerbating factors

Relieving factors

Headache Description

- Character
  - vise-like
  - stabbing
  - throbbing
  - tingling
  - pulling
- Onset
  - day
  - night
  - related to activity
  - aura or associated symptoms

Headache Description

- Location
  - unilateral
  - bilateral
  - frontal
  - temporal
  - occipital
  - associated with other pain
- Duration
  - minutes
  - hours
  - days
  - daily

Headache Description

- Exacerbation
  - activity
  - light, sound
  - reading
  - stress
  - sleeplessness
  - hormonal variations
  - diet
  - environment changes
- Relief
  - rest
  - dark
  - medications
  - massage
  - caffeine

Associated conditions

- Sleep Disorder or Change in Sleep Pattern
- Depression/Anxiety
- Cognitive Impairment
- Other Injuries
- Stress

Habits

- Smoking
- Alcohol Intake
- Exercise
- Caffeine Intake
- Foods - aged cheeses, nitrite/nitrate containing foods, MSG, chocolate, caffeine, skipping meals
- Menses

Medication Use

- Evaluate for the possibility of “rebound” headache
  - caffeine, analgesics, NSAIDs, triptans, ergotamines, butalbital, aspirin, acetaminophen

Physical Examination

- Posture
- Vascular structures
- Nerves
- Joints (neck, TMJ)
- Muscles – facial, cranial, cervical and shoulder girdle, trunk
- Sinuses and ENT
- Ocular assessment (fundoscopic exam)
- Pain related behavior
- Range of motion – neck and jaw

Guidelines for Neuroimaging for Post-traumatic Headache

- Increasing headache in first 24 hours
- Appearance of neurologic signs/symptoms
- Unusual pattern (nocturnal, positional changes)
- Age > 50 with persistent headaches
- Seizures
- Severe headache triggered by cough, coitus, exertion
- Sudden severe headache

Tension-Type Headache

- Most common variety but least studied
  - Prevalence 30-78%
  - Episodic TTH – **peripheral pain** and central pain mechanisms
  - Chronic TTH – **central pain** and peripheral pain mechanisms
  - May overlap with milder migraines without aura

Tension-Type Headache

- Intermittent OR continuous
- Pressing or tightening
- Lasts 30 minutes to continuous
- Bilateral location
- Mild or moderate intensity
- Not aggravated by routine physical activity
- Temporary relief with analgesics
- Increases throughout the day
- No nausea or vomiting
- Either photophobia or phonophobia, not both
- Pericranial tenderness

Causes of TTH

- Mental stress
- Local myofascial release of irritants
- Combination
- Migraine headache

Migraine
Diagnostic criteria

- At least 5 attacks
- At least 2 of the following:
  - Unilateral location
  - Pulsating quality
  - Moderate or severe pain intensity
  - Aggravation by routine physical activity
- At least 1 of the following:
  - Nausea and/or vomiting
  - Photophobia and phonophobia
- HA lasts 4-72 hours untreated

Characteristics

- Commonly frontotemporal
- Migraine without aura – more common, higher attach frequency, more disabling
- Migraine with aura – attacks of reversible focal neurological symptoms that last for less than 60 minutes, followed by headache
  - Visual (zigzag, scotoma), sensory (pins and needles, numbness), dysphasia

Pathophysiology of migraine

- Migraine without aura
  - Nitric oxide (NO) and calcitonin-gene-related peptide (CGRP) produce sensitization of perivascular nerve terminals
- Migraine with aura
  - Aura – regional cerebral blood flow decreases
  - Cortical spreading depression

Cervicogenic Headache Diagnostic criteria

- Pain referred from a source in the neck and perceived in the head or face
- Clinical, laboratory, or imaging evidence of disorder within the C spine or soft tissues of the neck
- Clinical signs that implicate a source of pain in the neck
- Abolition of headache following diagnostic blockade of a cervical structure or its nerve supply
- Pain resolves within 3 months after successful treatment of causative disorder or lesion

Occipital Neuralgia

- Tingling and numb sensation in posterior scalp area
- Radiation in frontotemporal region
- Localized tenderness to palpation
- Restriction in cervical ROM

Chronic Headache

- Tension-type headache
- Chronic migraine
- Hemicrania continua

Rebound headache

- Can occur with regular use of any analgesic or abortive medication including caffeine

Pharmacotherapy for Headaches

- Abortive – stop or prevent the progression of a headache or reverse a headache
- Preventive (prophylactic) – reduce the frequently and severity of the migraine attack, make acute attacks more responsive to abortive therapy, improve quality of life

Abortive Pharmacotherapy for Migraine Headache

Moderate	Severe	Extremely Severe
NSAIDS	Naratriptan	DHE (IV)
Isometheptene	Rizatriptan	Opioids
Ergotamine	Sumatriptan	Dopamine antagonists
Naratriptan	Zomitriptan	
Rizatriptan	Almotriptan	
Sumatriptan	Frovatriptan	
Zolmitriptan	DHE (NS/IM)	
Almotriptan	Ergotamine	
Frovatriptan	Dopamine antagonists	
Dopamine antagonists		

Prophylactic Therapy for Migraine

First Line	High efficacy	Beta-blockers
		TCAs
		Divalproex
	Low efficacy	Verapamil
		NSAIDs
		SSRIs
Second Line	High efficacy	Methysergide
		Flunarizine
		MAOIs
	Unproven efficacy	Cyproheptadine
		Gabapentin
		Lamotrigine

Other possibilities

- Riboflavin (Vitamin B-2) alters neuronal oxidative metabolism
- Magnesium reduces neuronal excitability
- Treat associated disorders (depression, insomnia)
- Monitor for dietary triggers

Hearing loss

- Rare with mild TBI
  - Sensorineural- typically ~4 kHz, often permanent
  - Conductive
    - Tympanic membrane rupture
    - Hemotympanum
    - Ossicular chain disruption
    - Conductive loss usually improves spontaneously- if not, often amenable to surgery

Sleep disturbance

- Frequent after mild TBI
  - Usually multifactorial- pain, psychologic factors, altered arousal
- Treat first by optimizing sleep hygiene
  - Eliminate naps
  - No caffeine
  - Sleep in appropriate environment
  - “wind down”
- Treat pain, affective disorders (depression, PTSD, anxiety)

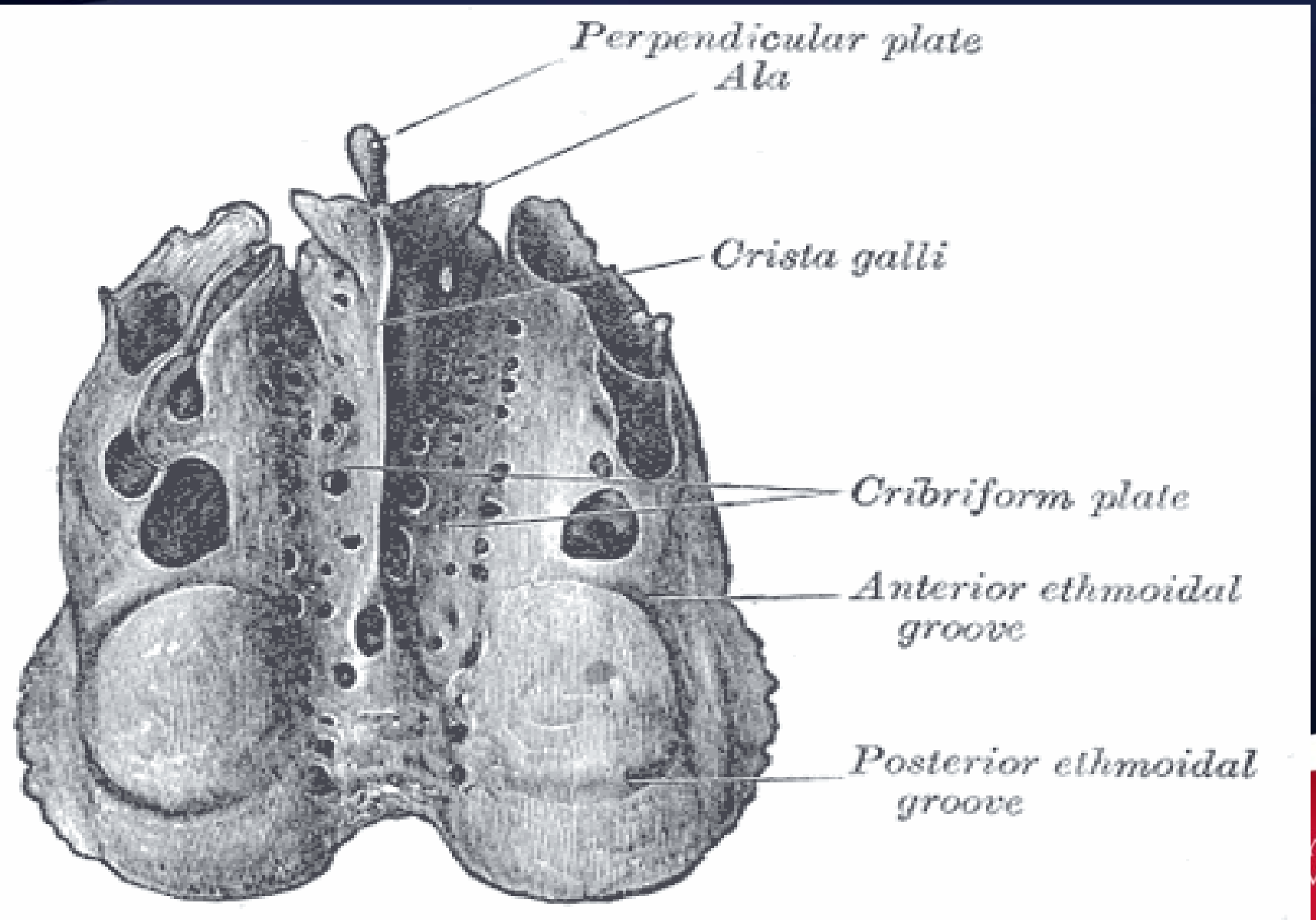
Sleep disturbance - medications

- Scheduled use is preferable to prn
- Trazodone is first line agent
- Melatonin, ramelteon
- Ambien may have cognitive side effects
- Avoid benzodiazepines due to depressive and habit forming characteristics

Smell / Taste changes

- Causes of olfactory impairment
  - Damage to nasal passages
  - Shear injury to olfactory nerve (at cribriform plate)
  - Inferomedial frontal lobe contusions
- Treatment
  - Limited
    - Education
    - Surgery, if nasal damage
- Damage to taste mechanisms extremely rare (sweet, sour, salty, bitter)

Cribriform plate – Ethmoid bone



Visual symptoms

- Diplopia
- Impaired accomodation
- Convergence dysfunction
- Photophobia
- Usually spontaneously improve after mild TBI
  - If symptoms persist, may require referral to neuro-ophthalmologist

Other Symptoms associated with mild TBI

- Neck pain/Whiplash
  - Frequently associated with mild TBI
  - Whiplash symptoms may be confused with or exacerbate symptoms of mild TBI
    - Headache
    - Visual symptoms
    - Dizziness (cervical vertigo)
    - Cognitive symptoms

Considerations in Diagnosis and Treatment of mild TBI

- May be hard to establish direct cause and effect relationship between injury and symptoms
- Psychologic factors often present, particularly in the slow to recover population
- Exaggeration (usually unconscious) of symptoms may be present, particularly in the context of litigation/compensation
- Mild TBI requires holistic, multidisciplinary management